



Critical Care Therapy and Respiratory Care Section

Category:	Clinical
Section:	Nutritional Assessment
Title:	Use of VMAX Metabolic Monitor: Open Canopy and Ventilator Interfacing
Policy #:	02
Revised:	03/00

1.0 DESCRIPTION

- 1.1 Definition: The VMAX is a Windows 95 based device that measures metabolic parameters to assess nutritional status of patients. Specifically, the monitor measures oxygen consumption and carbon dioxide production so that an estimate of the respiratory quotient (RQ) is obtained. In addition, the VMAX unit can perform pulmonary function tests such as flow volume loops and maximal ventilatory ventilation maneuvers.
- 1.2 Indications: The VMAX monitor will be used to assess the nutritional status of both pediatric and adult patients, especially as nutritional status relates to the need for adjustment of total parental nutrition therapy. The cart can also be used to assess work of breathing (WOB). The cart will be available upon physician request or upon request of the approving official for the Metabolic Cart Consult Service. Metabolic assessment is especially indicated in patients whose nutritional status is poor due to gastrointestinal pathology, neurologic dysfunction, or anorexia. In addition, the monitor will be used to assess pulmonary function parameters in patients whose pulmonary status is in question.
- 1.3 Contraindications:
 - 1.3.1 Do not use the VMAX in the presence of flammable anesthetics.
 - 1.3.2 The monitor cannot be used with FIO₂ delivery above 0.85. Additionally, data collected with the use of the monitor becomes much less reliable for FIO₂s greater than 0.60.
 - 1.3.3 The monitor cannot be used during nebulization therapy.
- 1.4 Complications: Prior to and during the study, the patient should not be manipulated or stimulated in any way. As patient care needs dictate, a metabolic study may be aborted. Any activity with a patient during

monitoring will affect the quality of the study. NOTE: All patients should be NPO for at least 6 hours and resting for 30 minutes prior to a study.

1.5 Precautions

- 1.5.1 Do not open the monitor covers for any reason. Opening the covers has the potential for creating a significant electrical shock hazard.
- 1.5.2 The monitor should not be steam autoclaved, exposed to ethylene oxide, or immersed in any liquid.
- 1.5.3 The power cord should be properly connected to a grounded three-wire outlet and unplugged prior to cleaning.
- 1.5.4 Because pump flow may not meet the patients flow needs, it may be necessary to adjust the pump flow as indicated by the vol. bar on computer screen.
- 1.5.5 When measuring a ventilated patient, who is being monitored via a capnometer, the sampling gas flow to the capnometer must be collected and fed back to the VMAX.
- 1.5.6 Canopy measurements should be attended at all times. In case of a power failure, remove the canopy from the patient immediately.
- 1.5.7 Microbial contamination of the internal sampling system requires servicing by Sensormedics personnel.
- 1.5.8 Use only Sensormedics sampling tubing and accessories and do not alter the length or diameter of the tubes.
- 1.5.9 Allow at least 30 minutes warm-up time prior to calibration and monitoring.
- 1.5.10 Ammonia and acetone-based cleaners should be avoided as these may damage the monitor surface.
- 1.5.11 Good data are dependent on a leak-free system. Monitor the measurements continuously during operation and refer to the Troubleshooting Guide when necessary. When measuring a patient with an uncuffed or leaky endotracheal tube, it is necessary to modify the system to collect **all** expired gases. See Selby, et al. Critical Care Medicine 1995;23:365-370 (attached). Be aware that chest tube leaks will cause erroneous data.

- 1.5.12 Ensure that the correct adapters and tubings are being used prior to initiating a study.
- 1.5.13 Adjustments to the FIO2 should not be made during a study. Optimal results are obtained only during steady states. If a steady state is never achieved the test should be run for 20 minutes and all data points included in calculations.
- 1.6 Adverse Reactions and Interventions: Adjustments to nutrition therapy (based on faulty metabolic data) may jeopardize a patient's nutritional status. To ensure quality studies:
 - 1.6.1 The VMAX should be flow calibrated daily when in use. Calibration procedures must be strictly followed before any test is to be performed. Maintenance of the unit will be performed on an "as needed" basis at the direction of a Sensormedics service representative. Refer to the operator's manual for troubleshooting guidelines.
 - 1.6.2 Any study, which reveals that a steady state was not achieved, should be questioned and efforts made to correct errors in the sampling of exhaled gases. **NOTE:** It is imperative that the operator remains at the bedside with every measurement to check for quality and to assist the patient as needed.

2.0 EQUIPMENT AND MATERIALS

- 2.1 VMAX Monitor with printer and sampling tubing.
- 2.2 Canopy hood with 12 sections of corrugated tubing for open canopy study and 2-3 links of corrugated tubing for ventilator study. **NOTE:** Use of longer tubing for ventilator studies can result in studies not reaching a steady state.

3.0 PROCEDURE

- 3.1 Turn on unit at breaker on right side of cart. Turn on the lap top computer and printer.
- 3.2 Click on VMAX icon (If DOS display comes up on screen type in "WIN" then press enter).

TO CALIBRATE FLOW SENSOR:

- 3.3 Click on flow sensor calibration.

- 3.4 Click F1 to start.
 - 3.4.1 Attach 3L syringe to mass flow generator and zero sensor by performing two full strokes.
 - 3.4.2 Hit space bar and allow stabilization. The screen will automatically change to calibration screen.
 - 3.4.3 Perform six full strokes. The screen will automatically change to verification screen.
 - 3.4.4 Perform four full strokes.
 - 3.4.5 Perform one full stroke between red lines.
 - 3.4.6 Perform one full stroke on the line.
 - 3.4.7 Check % Target at top right hand corner of screen. If percentage is within $\pm 3\%$ of 100%, save results by pressing F3 and proceed with test. **NOTE:** A dialog box will appear if error is noted and test needs to be repeated.
 - 3.4.8 Place Mass Flow Generator in back of VMAX unit with waffle side in.

TO PERFORM CANOPY STUDY:

- 3.5 Go to new study for new patient. Enter: height, weight, birthday, sex, and ID number, press F3 to save. **NOTE:** If patient has had a prior study go under Find A Patient, type in last name. Click on F1 to bring up list. Highlight and double click on desired patient. Press F2 to store patient information.
- 3.6 Double click on Exercise/Metabolic Test icon. Select canopy or ventilator study then F1 to start test.
- 3.7 Turn gas tanks on and perform gas calibration.
- 3.8 Click on F1 to start calibration. A green dialog box will appear in lower right corner when calibration is complete. **Turn off gas tanks.**
- 3.9 Go to Exit in top left corner to begin test, or simply press F3.
- 3.10 A dialog box appears and prompts you to switch pump on. Place canopy over patient with the outlet positioned close to the patient's mouth, tuck in

plastic drape under the pillow and around the patient to avoid leakage.

NOTE: The pump must be turned on prior to placing canopy on patient.

3.11 When all data points green (Vpump will remain blue), hit F8 to start actual test.

3.12 Pump flow for Adults:30 lpm
Ped.: 20 lpm

NOTE: If Vol. Bar is consistently yellow or red adjust flow by toggle switch at right bottom of screen.

3.13 Perform test for 15 minutes if steady state is achieved within 5 minutes. A green dialog box will appear at bottom of screen when steady state is met. If steady state is not achieved within 5 minutes, perform study for 20 minutes.

3.14 When study is completed go to Exit and click on Y to end test.

3.15 Remove patient connections and switch off pump.

3.16 Hit space bar to continue.

3.17 Dialog box will appear for therapist comments. Hit F3 to store desired comments.

3.18 Steady state graphic edit box will appear.

TO SELECT STEADY STATE:

3.19 Highlight Tab 1 SS#.

3.20 Place cursor at the beginning of steady state (determined by black dots).

3.21 Click and hold the left side of the mouse and drag to select data points desired.

3.22 Highlight Tab 2 SS# and select second set of data points.

3.23 Highlight Tab 3 SS# and select third set of data points.

NOTE: If no steady state is achieved highlight entire study.

3.24 To average highlighted areas click in box next to SS#4 at bottom right of screen.

3.25 Click on F3 to save.

TO OBTAIN REPORTS:

3.26 Click on Reports.

3.27 Select Canopy REE Report.

3.28 Click on View at top left of screen.

3.29 Click on Print.

3.30 Click on Report at top of screen.

3.31 Select REE 4 Quadrant Plot.

3.32 Click on **View**.

3.33 Click on Print.

TO PERFORM VENTILATOR STUDY:

3.34 Replace green sample line on back of VMAX unit with ventilator sample tubing and place other end of sample tubing on ventilator after the concha column. **NOTE:** The inspiratory sampling tubing must be placed downstream from the humidifier which acts as a mixing chamber for further equilibration of the FI02.

3.35 Place Mass Flow Generator on back of ventilator using premounted Velcro strips.

3.36 Connect 2-3 links of corrugated tubing on Mass Flow Generator and connect to ventilator.

3.37 Go to section 3.5 to continue with study. **NOTE:** Do not turn on pump for ventilator studies.

4.0 POST PROCEDURE

4.1 Shut down computer by clicking on the "Start" button in the lower left hand corner. Select "Shutdown" button. A dialog box will appear, select "Shutdown" and click on "OK". The screen will go blank, then a text message will appear stating, "It is now safe to shut off computer". Now you can turn off the machine via the breaker on the right side of the machine.

5.0 REFERENCES

- 5.1 VMAX Operator's Manual
- 5.2 Selby et al. Indirect calorimetry in mechanically ventilated children: a new technique that overcomes the problem of endotracheal tube leak. Crit. Care Med. 1995;23:365-370.
- 5.3 AARC Clinical Practice Guideline: Metabolic Measurement Using Indirect Calorimetry during Mechanical Ventilation

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